

INFLUENCE OF TROPHY HARVEST ON THE POPULATION AGE STRUCTURE OF ARGALI *Ovis ammon* IN MONGOLIA

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To assess the influence of trophy hunting on Mongolian Argali *Ovis ammon*, we compared the ages of trophy rams (n=64) taken through Mongolia's legal hunting programme with those of mature rams that died of natural causes (n=116). A two-sample Kolmogorov-Smirnov test indicated that the distributions of the two groups were different ($P=0.001$). A two-sample t-test indicated the distributional differences were due, at least in part, to differences in the mean ages between the natural deaths and hunter harvested samples ($P=0.001$); the distributions were not centered at the same value or the means in the two populations differ. Application of the Central Limit Theorem affirms that the distribution of the sample mean ages for natural death and hunter harvested populations will be approximately normal, making the t-test applicable. The mean age for the natural death sample was 8.7 years (range: 7.0–13.0) compared to 9.4 (range: 7.0–13) for the hunter harvested sample. At the 95% confidence level, the true difference in ages between the trophy kills and natural deaths is between 3 months and 1 year. Since on an average, rams killed by hunters are older than the average age of natural death for mature rams, the legal hunting programme is having little effect on ram age structure. Thirteen years may represent the upper limit of lifespan for wild Mongolian Argali, which is slightly shorter than the life span of North American wild sheep, namely Thinhorn Sheep *Ovis dalli* and Bighorn Sheep *Ovis canadensis*.

Key words: Argali, age of mortality, natural mortality, trophy harvest age, trophy harvest effect

INTRODUCTION

Trophy hunting of large wild ungulates is controversial and a matter of concern to wildlife conservation practitioners (Coltman *et al.* 2003; Festa-Bianchet and Lee 2009; Frisina and Frisina 2004; Harris *et al.* 2002). Trophy hunting usually involves hunters seeking the largest males of a targeted taxon in a specific geographic area (Frisina *et al.* 2000). Revenues from trophy hunting fees can be a potential source of much needed funds for conserving wild species (Frisina and Tareen 2009; Harris *et al.* 2002; Schaller 1998; Valdez *et al.* 1995). Among the concerns regarding the harvesting of trophies by hunters are potential disruption of population social structure, social order, and maintenance of genetic diversity (Coltman *et al.* 2003; Festa-Bianchet 2003; Harris *et al.* 2002; Milner *et al.* 2006). To address this concern for Mongolian wild sheep populations, we compared the ages at which hunters harvest trophy rams with the ages at which mature rams were found dead in the field of natural causes. This approach may provide insights as to the degree that natural age structure may be altered, and thus, potentially impacting the natural dynamics of wild sheep populations in Mongolia.

Argali (*Ovis ammon*) are wild sheep that occur throughout central Asia, including Mongolia's steppe, undulating desert, and rugged mountainous landscapes (Geist 1991; Mitchell and Frisina 2007; Valdez 1982). Although their ranges are not well-defined and some overlap may occur, Shackleton and Lovari (1997) recognise two subspecies of

argali as occurring in Mongolia: the Altai Argali (*O. a. ammon*) of western Mongolia and the Gobi Argali (*O. a. darwini*) of the Gobi Desert in southern Mongolia. Both are listed as rare by the Mongolian Government (MNEM 1997) and are included in the United States Fish and Wildlife Service list of endangered and threatened wildlife and plants (USFWS 2012). In addition, they are listed as vulnerable and endangered by the IUCN (2012) and in Appendix II of CITES (CITES 2012).

Mongolia is a central Asian landlocked country, encompassing about 1,656,000 sq. km of which approximately 25% is potential Argali habitat (ASM 1990). Limited international sport hunting of argali has been permitted since 1968. The current Mongolian hunting law was established in 1995 and is administered by the Mongolian Ministry for Nature and the Environment. The hunting law regulates the commercial use of wildlife. Although trophy hunting is controversial, hunting fees are an important source of foreign currency in a badly depressed economy (Asia Foundation 2009; MNEM 1995; Wingard and Purevdolgor 2001). Improved management of wildlife is one of Mongolia's best opportunities for diversifying an agriculture-based economy that will likely continue to depend on rangeland and resource production (Valdez *et al.* 1995).

Argali populations are believed to have declined in Mongolia and throughout central Asia during the last century (Harper 1945; Heptner *et al.* 1989; Mallon 1985; Mallon *et al.* 1997; Reading *et al.* 1997). Specific and comparable

country-wide population status and trend information for this species, a fundamental requirement for conservation (Wegge 1997), is limited. Population estimates for Mongolia reported by Frisina *et al.* (2007) and Frisina *et al.* (2010) indicate that from 2002 through 2009 Argali populations were stable to slightly increasing.

Here, we compare the ages of hunter harvested trophy rams with ages of mature rams found dead in the field of natural causes as a means to monitor the influence of trophy hunting on argali male age structure.

MATERIAL AND METHODS

Our study area included the entire Mongolian Argali range as described by Frisina *et al.* (2007). Mongolia's argali range is diverse, ranging from alpine communities in the Altai Mountains in the west, to steppe and desert communities in central and eastern areas. Plant communities are diverse and typical of the central Asian plateau (Hilbig 1995; Gunin *et al.* 1999). Several of our survey sites were previously described in detail (Frisina and Boldbaatar 1998; Frisina and Gombosuren 1999, 2000; Frisina *et al.* 2004, 2007, 2010).

Mongolia's climate is characterised by long, cold winters and short, humid summers. January is the coldest month with temperatures of -40°C or colder in contrast to $>38^{\circ}\text{C}$ during summer. Rainfall is highly variable, averaging 460 mm in the mountains and 100 mm in the Gobi Desert. Severe winters and summer drought are not uncommon, and at times can lead to significant natural mortality of argali on portions of the range (Frisina *et al.* 2007).

From 1997 through 2002, mature argali rams five years or older found dead in the field of natural causes were aged using the horn growth segment ageing technique (Geist 1966). Wolves (*Canis lupus*) are a principle predator on argali (Schaller 1998). Among the other more common forms of natural mortality for mature males are predation by Snow Leopard (*Uncia uncia*), and stress imposed by a very severe environment. Animals found dead in the field were examined for indications of human caused mortality (i.e., head missing from mature males, bullet wounds, etc.). If no sign of human caused mortality was apparent the animal was included in the natural mortality sample. A number of trophies taken by hunters participating in Mongolia's legal hunting programme were likewise aged.

RESULTS

A sample of 64 argali rams of age 5 and older found dead in the field of natural causes was compared to a sample of 116 argali trophies harvested by hunters through

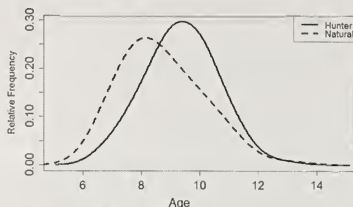


Fig. 1: Age distribution and frequency of occurrence for natural mortality and hunter harvested mature rams of Argali in Mongolia

Mongolia's legal hunting programme. Relative frequency of occurrence in relation to age for both samples is graphically displayed in Fig. 1. A two sample Kolomogorov-Smirnov Test (KS) indicated the distributions were different ($P = 0.001$). A two-sample t-test was used to determine if the distributional differences were at least in part due to differences in the mean ages between the natural death and hunter harvested samples. The two-sided two-sample t-test resulted in a P-value of 0.001, indicating the distributions were not centred at the same value, or the mean ages in the two populations differ. Application of the Central Limit Theorem affirms that the distribution of the sample mean ages for natural death and hunter harvested populations will be approximately normal, which allows for the valid use of the two sample t-test (Ramsey and Schafer 2002). The mean age for the natural death sample of 64 was 8.7 years (range: 7.0–13.0) compared to 9.4 years (range: 7.0–13.0) for the hunter harvested sample of 116. Applying a 95% confidence interval, we determined the true difference in ages between the trophy killed argali and those that died of natural causes is between 3 months and 1 year, with the trophy killed argali living longer.

Table 1: Mongolian Argali harvest quotas 1992 through 2011

Year(s)	*Harvest Quota
1992-1994	15
1995-1996	20
1997	30
1998	35
1999	45
2000	40
2001	45
2002-2006	80
2007-2009	60
2010-2011	50

*Baasanhu Jantzen and Mongolian Ministry for Nature and the Environment (pers. comm.).

These data indicate that the natural life expectancy for rams surviving their first five years is, on the average, only an additional 3.7 years. The oldest argali in our sample included a hunter trophy aged 13 years, and a natural death of the same age.

DISCUSSION

Hunter Harvest

The average age of rams killed by hunters (9.4) is older than the average age of natural death (8.7) and indicates that Mongolia's legal trophy hunting programme is having little effect on the mature ram age structure. Ideally, mortality resulting from trophy hunting should remove animals destined to die shortly of natural causes (Wegge 1997); this appears to be the case for most of the Mongolian trophy harvest. Our results are similar to Schaller (1998) who described argali as animals with a relatively short lifespan, seldom reaching 10 years. Natural environmental factors and interacting population parameters are apparently exerting more influence on its life expectancy than the trophy hunting programme, partially a result of Mongolia limiting harvest quota system. The selective effects of trophy hunting can be expected to increase with intensity of hunting pressure (Festa-Bianchet *et al.* 2006) and, conversely, have limited effect at low harvest levels. Quotas varied by year, from 15 to 80 from 1992 through 2011 (Table 1). Mongolia's harvest quota is conservative relative to total argali numbers. Using different methods Frisina *et al.* (2010) and Harris *et al.* (2010) developed population estimates of 26,155 and 17,903 argali respectively for fall 2009. Using these estimates, Mongolia's current harvest quota of 50 potentially allows for harvest of 0.2 to 0.3 % of the total population in trophy rams. Following a 2002 census in which 20,226 argali were estimated, Frisina *et al.* (2007) determined that with a conservation plan in place a sustainable quota of 202–404 individuals could potentially be harvested. Harris (1993), following a review of the literature for large ungulates with polygamous breeding strategies, determined that with a conservation plan in place

harvest quotas representing 1 to 2% of the total population may be sustainable. Swank (1958) recommended limiting trophy harvest to not more than 12% of the males in the population and Wegge (1997) indicated that harvesting males within 10 to 20% of the replacement level for the trophy-sized segment is safe and not expected to have any negative effects. Mongolia's harvest quota is well within these limits. The apparent lack of hunting impact upon age structure of mature males supports the conclusion that present hunting quotas are appropriate. If harvest levels increased significantly, the influence of hunting on age structure may increase.

Life Span

Thirteen years may represent the upper limit of lifespan for wild argali in Mongolia. Schaller (1998) reported a maximum age between 10 and 11 years for argali of the Tibetan steppe. Maximum ages reported for North American Thinhorn Sheep *Ovis dalli* ranged between 13 and 15 years (Deavey 1947; Loehr *et al.* 2007; Simmons *et al.* 1984). Similarly, Hansen (1961) reported a maximum age of 15 years for Bighorn Sheep *Ovis canadensis*. It appears that argali may have a slightly shorter maximum lifespan than these two species of North American wild sheep.

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